

$\chi_{b0}(2P)$

$$J^G(J^{PC}) = 0^+(0^{++})$$

J needs confirmation.

Observed in radiative decay of the $\Upsilon(3S)$, therefore $C = +$. Branching ratio requires E1 transition, M1 is strongly disfavored, therefore $P = +$.

$\chi_{b0}(2P)$ MASS

VALUE (MeV)	DOCUMENT ID
10232.5 ± 0.4 ± 0.5 OUR EVALUATION	From γ energy below, using $\Upsilon(3S)$ mass = 10355.2 ± 0.5 MeV

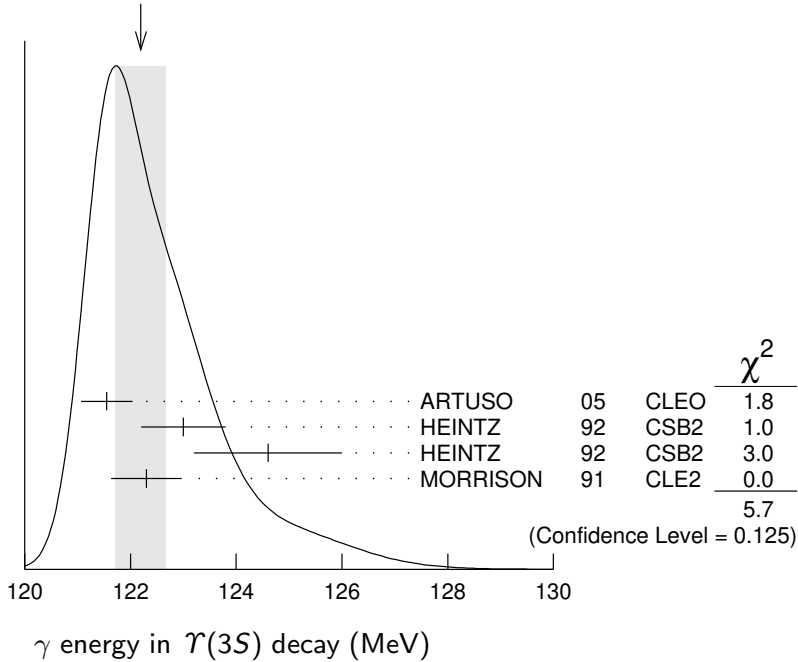
$m_{\chi_{b1}(2P)} - m_{\chi_{b0}(2P)}$

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
23.8 ± 1.7	LEES	14M BABR	$\Upsilon(3S) \rightarrow \gamma\gamma\mu^+\mu^-$

γ ENERGY IN $\Upsilon(3S)$ DECAY

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
121.9 ± 0.4 OUR EVALUATION		Treating systematic errors as correlated		
122.2 ± 0.5 OUR AVERAGE		Error includes scale factor of 1.4. See the ideogram below.		
121.55 ± 0.16 ± 0.46		ARTUSO	05 CLEO	$\Upsilon(3S) \rightarrow \gamma X$
123.0 ± 0.8	4959	¹ HEINTZ	92 CSB2	$e^+e^- \rightarrow \gamma X$
124.6 ± 1.4	17	² HEINTZ	92 CSB2	$e^+e^- \rightarrow \ell^+\ell^-\gamma\gamma$
122.3 ± 0.3 ± 0.6	9903	MORRISON	91 CLE2	$e^+e^- \rightarrow \gamma X$

WEIGHTED AVERAGE
122.2 ± 0.5 (Error scaled by 1.4)



¹A systematic uncertainty on the energy scale of 0.9% not included. Supersedes NARAIN 91.

²A systematic uncertainty on the energy scale of 0.9% not included. Supersedes HEINTZ 91.

$\chi_{b0}(2P)$ DECAY MODES

Mode	Fraction (Γ_i/Γ)	Confidence level
$\Gamma_1 \quad \gamma \Upsilon(2S)$	$(1.38 \pm 0.30) \%$	
$\Gamma_2 \quad \gamma \Upsilon(1S)$	$(3.8 \pm 1.7) \times 10^{-3}$	
$\Gamma_3 \quad D^0 X$	$< 8.2 \%$	90%
$\Gamma_4 \quad \pi^+ \pi^- K^+ K^- \pi^0$	$< 3.4 \times 10^{-5}$	90%
$\Gamma_5 \quad 2\pi^+ \pi^- K^- K_S^0$	$< 5 \times 10^{-5}$	90%
$\Gamma_6 \quad 2\pi^+ \pi^- K^- K_S^0 2\pi^0$	$< 2.2 \times 10^{-4}$	90%
$\Gamma_7 \quad 2\pi^+ 2\pi^- 2\pi^0$	$< 2.4 \times 10^{-4}$	90%
$\Gamma_8 \quad 2\pi^+ 2\pi^- K^+ K^-$	$< 1.5 \times 10^{-4}$	90%
$\Gamma_9 \quad 2\pi^+ 2\pi^- K^+ K^- \pi^0$	$< 2.2 \times 10^{-4}$	90%
$\Gamma_{10} \quad 2\pi^+ 2\pi^- K^+ K^- 2\pi^0$	$< 1.1 \times 10^{-3}$	90%
$\Gamma_{11} \quad 3\pi^+ 2\pi^- K^- K_S^0 \pi^0$	$< 7 \times 10^{-4}$	90%
$\Gamma_{12} \quad 3\pi^+ 3\pi^-$	$< 7 \times 10^{-5}$	90%
$\Gamma_{13} \quad 3\pi^+ 3\pi^- 2\pi^0$	$< 1.2 \times 10^{-3}$	90%
$\Gamma_{14} \quad 3\pi^+ 3\pi^- K^+ K^-$	$< 1.5 \times 10^{-4}$	90%
$\Gamma_{15} \quad 3\pi^+ 3\pi^- K^+ K^- \pi^0$	$< 7 \times 10^{-4}$	90%
$\Gamma_{16} \quad 4\pi^+ 4\pi^-$	$< 1.7 \times 10^{-4}$	90%
$\Gamma_{17} \quad 4\pi^+ 4\pi^- 2\pi^0$	$< 6 \times 10^{-4}$	90%

$\chi_{b0}(2P)$ BRANCHING RATIOS

$\Gamma(\gamma \Upsilon(2S))/\Gamma_{\text{total}}$	Γ_1/Γ			
VALUE (%)	CL%	DOCUMENT ID	TECN	COMMENT
1.38 ± 0.30 OUR AVERAGE				
$1.31 \pm 0.27^{+0.13}_{-0.12}$	3,4	LEES	14M BABR	$\Upsilon(3S) \rightarrow \gamma \gamma \mu^+ \mu^-$
$3.6 \pm 1.6 \pm 0.3$	3,5	HEINTZ	92 CSB2	$e^+ e^- \rightarrow \ell^+ \ell^- \gamma \gamma$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●				
< 2.8	90	⁶ LEES	11J BABR	$\Upsilon(3S) \rightarrow X \gamma$
< 8.9	90	⁷ CRAWFORD	92B CLE2	$e^+ e^- \rightarrow \ell^+ \ell^- \gamma \gamma$

³ Assuming $B(\Upsilon(2S) \rightarrow \mu^+ \mu^-) = (1.93 \pm 0.17)\%$.

⁴ LEES 14M reports $[\Gamma(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(2S))/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))] = (7.7 \pm 1.6) \times 10^{-4}$ which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) = (5.9 \pm 0.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

⁵ Recalculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) \times B(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(2S)) = (0.28 \pm 0.12 \pm 0.03)\%$ using $B(\Upsilon(2S) \rightarrow \mu^+ \mu^-) = (1.44 \pm 0.10)\%$. Supersedes HEINTZ 91.

⁶ LEES 11J quotes a central value of $\Gamma(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(2S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))/\Gamma_{\text{total}} = (-0.3 \pm 0.2^{+0.5}_{-0.4})\%$.

⁷ Using $B(\Upsilon(2S) \rightarrow \mu^+ \mu^-) = (1.37 \pm 0.26)\%$, $B(\Upsilon(3S) \rightarrow \gamma \gamma \Upsilon(2S)) \times 2 B(\Upsilon(2S) \rightarrow \mu^+ \mu^-) < 1.19 \times 10^{-4}$, and $B(\Upsilon(3S) \rightarrow \chi_{b0}(2P) \gamma) = 0.049$.

$\Gamma(\gamma \Upsilon(1S))/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE (%)	CL%	DOCUMENT ID	TECN	COMMENT
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0.38 ± 0.17 OUR AVERAGE

0.36 ± 0.17 ± 0.03	8,9,10	LEES	14M BABR	$\Upsilon(3S) \rightarrow \gamma\gamma\mu^+\mu^-$
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0.9 ± 0.7 ± 0.1	9,11	HEINTZ	92 CSB2	$e^+e^- \rightarrow \ell^+\ell^-\gamma\gamma$
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• • • We do not use the following data for averages, fits, limits, etc. • • •

<1.2	90	12 LEES	11J BABR	$\Upsilon(3S) \rightarrow X\gamma$
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<2.5	90	13 CRAWFORD	92B CLE2	$e^+e^- \rightarrow \ell^+\ell^-\gamma\gamma$
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⁸ LEES 14M quotes $\Gamma(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(1S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))/\Gamma_{\text{total}} = (2.1 \pm 1.0) \times 10^{-4}$ combining the results from $\Upsilon(3S) \rightarrow \gamma\gamma\mu^+\mu^-$ samples with and without photon conversions.

⁹ Assuming $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.48 \pm 0.05)\%$.

¹⁰ LEES 14M reports $[\Gamma(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(1S))/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))]$ = $(2.1 \pm 1.0) \times 10^{-4}$ which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) = (5.9 \pm 0.6) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

¹¹ Recalculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) \times B(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(1S)) = (0.05 \pm 0.04 \pm 0.01)\%$ using $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.57 \pm 0.05)\%$. Supersedes HEINTZ 91.

¹² LEES 11J quotes a central value of $\Gamma(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(1S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))/\Gamma_{\text{total}} = (3.9 \pm 2.2^{+1.2}_{-0.6}) \times 10^{-4}$.

¹³ Using $B(\Upsilon(1S) \rightarrow \mu^+\mu^-) = (2.57 \pm 0.07)\%$, $B(\Upsilon(3S) \rightarrow \gamma\gamma \Upsilon(1S)) \times 2 B(\Upsilon(1S) \rightarrow \mu^+\mu^-) < 0.63 \times 10^{-4}$, and $B(\Upsilon(3S) \rightarrow \chi_{b0}(2P)\gamma) = 0.049$.

$\Gamma(D^0 X)/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
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<8.2 × 10⁻²	90	14,15 BRIERE	08 CLEO	$\Upsilon(3S) \rightarrow \gamma D^0 X$
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¹⁴ For $p_{D^0} > 2.5 \text{ GeV}/c$.

¹⁵ The authors also present their result as $(4.1 \pm 3.0 \pm 0.4) \times 10^{-2}$.

$\Gamma(\pi^+ \pi^- K^+ K^- \pi^0)/\Gamma_{\text{total}}$ Γ_4/Γ

VALUE (units 10 ⁻⁴)	CL%	DOCUMENT ID	TECN	COMMENT
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<0.34	90	16 ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma\pi^+\pi^-K^+K^-\pi^0$
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¹⁶ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow \pi^+\pi^-K^+K^-\pi^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))]$ < 2×10^{-6} which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) = 5.9 \times 10^{-2}$.

$\Gamma(2\pi^+ \pi^- K^- K_S^0)/\Gamma_{\text{total}}$ Γ_5/Γ

VALUE (units 10 ⁻⁴)	CL%	DOCUMENT ID	TECN	COMMENT
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<0.5	90	17 ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 2\pi^+\pi^-K^-K_S^0$
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¹⁷ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 2\pi^+\pi^-K^-K_S^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))]$ < 3×10^{-6} which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) = 5.9 \times 10^{-2}$.

$\Gamma(2\pi^+\pi^-K^-K_S^0 2\pi^0)/\Gamma_{\text{total}}$ **Γ_6/Γ**

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<2.2	90	¹⁸ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 2\pi^+\pi^-K^-2\pi^0$
¹⁸ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 2\pi^+\pi^-K^-K_S^0 2\pi^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))]$ < 13×10^{-6} which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) = 5.9 \times 10^{-2}$.				

$\Gamma(2\pi^+2\pi^-2\pi^0)/\Gamma_{\text{total}}$ **Γ_7/Γ**

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<2.4	90	¹⁹ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 2\pi^+2\pi^-2\pi^0$
¹⁹ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 2\pi^+2\pi^-2\pi^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))]$ < 14×10^{-6} which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) = 5.9 \times 10^{-2}$.				

$\Gamma(2\pi^+2\pi^-K^+K^-)/\Gamma_{\text{total}}$ **Γ_8/Γ**

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<1.5	90	²⁰ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 2\pi^+2\pi^-K^+K^-$
²⁰ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 2\pi^+2\pi^-K^+K^-)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))]$ < 9×10^{-6} which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) = 5.9 \times 10^{-2}$.				

$\Gamma(2\pi^+2\pi^-K^+K^-\pi^0)/\Gamma_{\text{total}}$ **Γ_9/Γ**

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<2.2	90	²¹ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 2\pi^+2\pi^-K^+K^-\pi^0$
²¹ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 2\pi^+2\pi^-K^+K^-\pi^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))]$ < 13×10^{-6} which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) = 5.9 \times 10^{-2}$.				

$\Gamma(2\pi^+2\pi^-K^+K^-2\pi^0)/\Gamma_{\text{total}}$ **Γ_{10}/Γ**

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<11	90	²² ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 2\pi^+2\pi^-K^+K^-2\pi^0$
²² ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 2\pi^+2\pi^-K^+K^-2\pi^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))]$ < 63×10^{-6} which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) = 5.9 \times 10^{-2}$.				

$\Gamma(3\pi^+2\pi^-K^-K_S^0\pi^0)/\Gamma_{\text{total}}$ **Γ_{11}/Γ**

<u>VALUE (units 10^{-4})</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<7	90	²³ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 3\pi^+2\pi^-K^-K_S^0\pi^0$
²³ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 3\pi^+2\pi^-K^-K_S^0\pi^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P))]$ < 39×10^{-6} which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma\chi_{b0}(2P)) = 5.9 \times 10^{-2}$.				

$\Gamma(3\pi^+3\pi^-)/\Gamma_{\text{total}}$ **Γ_{12}/Γ**

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<0.7	90	²⁴ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 3\pi^+ 3\pi^-$

²⁴ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 3\pi^+ 3\pi^-)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))]$
 $< 4 \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) = 5.9 \times 10^{-2}$.

$\Gamma(3\pi^+3\pi^-2\pi^0)/\Gamma_{\text{total}}$ **Γ_{13}/Γ**

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<12	90	²⁵ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 3\pi^+ 3\pi^- 2\pi^0$

²⁵ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 3\pi^+ 3\pi^- 2\pi^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))]$
 $< 72 \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) = 5.9 \times 10^{-2}$.

$\Gamma(3\pi^+3\pi^-K^+K^-)/\Gamma_{\text{total}}$ **Γ_{14}/Γ**

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<1.5	90	²⁶ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 3\pi^+ 3\pi^- K^+ K^-$

²⁶ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 3\pi^+ 3\pi^- K^+ K^-)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))]$
 $< 9 \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) = 5.9 \times 10^{-2}$.

$\Gamma(3\pi^+3\pi^-K^+K^-\pi^0)/\Gamma_{\text{total}}$ **Γ_{15}/Γ**

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<7	90	²⁷ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 3\pi^+ 3\pi^- K^+ K^-\pi^0$

²⁷ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 3\pi^+ 3\pi^- K^+ K^-\pi^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))]$
 $< 43 \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) = 5.9 \times 10^{-2}$.

$\Gamma(4\pi^+4\pi^-)/\Gamma_{\text{total}}$ **Γ_{16}/Γ**

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<1.7	90	²⁸ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 4\pi^+ 4\pi^-$

²⁸ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 4\pi^+ 4\pi^-)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))]$
 $< 10 \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) = 5.9 \times 10^{-2}$.

$\Gamma(4\pi^+4\pi^-2\pi^0)/\Gamma_{\text{total}}$ **Γ_{17}/Γ**

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<6	90	²⁹ ASNER	08A CLEO	$\Upsilon(3S) \rightarrow \gamma 4\pi^+ 4\pi^- 2\pi^0$

²⁹ ASNER 08A reports $[\Gamma(\chi_{b0}(2P) \rightarrow 4\pi^+ 4\pi^- 2\pi^0)/\Gamma_{\text{total}}] \times [B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))]$
 $< 38 \times 10^{-6}$ which we divide by our best value $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) = 5.9 \times 10^{-2}$.

$\Gamma(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(1S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))/\Gamma_{\text{total}}$
 $\Gamma_2/\Gamma \times \Gamma_{22}^{\Upsilon(3S)}/\Gamma \Upsilon(3S)$

VALUE (units 10^{-4})	CL%	DOCUMENT ID	TECN	COMMENT
<8.2	90	³⁰ LEES	11J BABR	$\Upsilon(3S) \rightarrow X\gamma$

³⁰ LEES 11J quotes a central value of $\Gamma(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(1S))/\Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))/\Gamma_{\text{total}} = (3.9 \pm 2.2_{-0.6}^{+1.2}) \times 10^{-4}$ and derives a 90% CL upper limit of $B(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(1S)) < 1.2\%$ using $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) = (5.9 \pm 0.6)\%$.

$B(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(1S)) \times B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) \times B(\Upsilon(1S) \rightarrow \ell^+ \ell^-)$

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
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1.4 ± 0.9 OUR AVERAGE

$1.7^{+1.5+0.1}_{-1.4-1.2}$	31 LEES	14M BABR	$\Upsilon(3S) \rightarrow \gamma \gamma \mu^+ \mu^-$
$1.3 \pm 1.0 \pm 0.3$	32 HEINTZ	92 CSB2	$\Upsilon(3S) \rightarrow \gamma \gamma \ell^+ \ell^-$

³¹ From a sample of $\Upsilon(3S) \rightarrow \gamma \gamma \mu^+ \mu^-$ with one converted photon.

³² Calculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) \times B(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(1S)) = (0.05 \pm 0.04 \pm 0.01)\%$ using $B(\Upsilon(1S) \rightarrow \mu^+ \mu^-) = (2.57 \pm 0.05)\%$.

$[B(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(1S)) \times B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))] / [B(\chi_{b1}(2P) \rightarrow \gamma \Upsilon(1S)) \times B(\Upsilon(3S) \rightarrow \gamma \chi_{b1}(2P))]$

VALUE (%)	DOCUMENT ID	TECN	COMMENT
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1.71 ± 0.80

33 LEES	14M BABR	$\Upsilon(3S) \rightarrow \gamma \gamma \mu^+ \mu^-$
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³³ From a sample of $\Upsilon(3S) \rightarrow \gamma \gamma \mu^+ \mu^-$ without converted photons.

**$\Gamma(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(2S)) / \Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) / \Gamma_{\text{total}}$
 $\Gamma_1 / \Gamma \times \Gamma_{22}^{\Upsilon(3S)} / \Gamma \Upsilon(3S)$**

VALUE (units 10^{-3})	CL%	DOCUMENT ID	TECN	COMMENT
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<1.6

90	34 LEES	11J BABR	$\Upsilon(3S) \rightarrow X \gamma$
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³⁴ LEES 11J quotes a central value of $\Gamma(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(2S)) / \Gamma_{\text{total}} \times \Gamma(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) / \Gamma_{\text{total}} = (-0.3 \pm 0.2^{+0.5}_{-0.4})\%$ and derives a 90% CL upper limit of $B(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(2S)) < 2.8\%$ using $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) = (5.9 \pm 0.6)\%$.

$B(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(2S)) \times B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) \times B(\Upsilon(2S) \rightarrow \ell^+ \ell^-)$

VALUE (units 10^{-5})	DOCUMENT ID	TECN	COMMENT
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4.4 ± 1.6 OUR AVERAGE

$6.6^{+4.9+2.0}_{-4.0-0.3}$	35 LEES	14M BABR	$\Upsilon(3S) \rightarrow \gamma \gamma \mu^+ \mu^-$
$4.0 \pm 1.7 \pm 0.3$	36 HEINTZ	92 CSB2	$\Upsilon(3S) \rightarrow \gamma \gamma \ell^+ \ell^-$

³⁵ From a sample of $\Upsilon(3S) \rightarrow \gamma \gamma \mu^+ \mu^-$ with one converted photon.

³⁶ Calculated by us. HEINTZ 92 quotes $B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P)) \times B(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(2S)) = (0.28 \pm 0.12 \pm 0.03)\%$ using $B(\Upsilon(2S) \rightarrow \mu^+ \mu^-) = (1.44 \pm 0.10)\%$.

$[B(\chi_{b0}(2P) \rightarrow \gamma \Upsilon(2S)) \times B(\Upsilon(3S) \rightarrow \gamma \chi_{b0}(2P))] / [B(\chi_{b1}(2P) \rightarrow \gamma \Upsilon(2S)) \times B(\Upsilon(3S) \rightarrow \gamma \chi_{b1}(2P))]$

VALUE (%)	DOCUMENT ID	TECN	COMMENT
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3.31 ± 0.56

37 LEES	14M BABR	$\Upsilon(3S) \rightarrow \gamma \gamma \mu^+ \mu^-$
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³⁷ From a sample of $\Upsilon(3S) \rightarrow \gamma \gamma \mu^+ \mu^-$ without converted photons.

$\chi_{b0}(2P)$ REFERENCES

LEES	14M	PR D90 112010	J.P. Lees <i>et al.</i>	(BABAR Collab.)
LEES	11J	PR D84 072002	J.P. Lees <i>et al.</i>	(BABAR Collab.)
ASNER	08A	PR D78 091103	D.M. Asner <i>et al.</i>	(CLEO Collab.)
BRIERE	08	PR D78 092007	R.A. Briere <i>et al.</i>	(CLEO Collab.)
ARTUSO	05	PRL 94 032001	M. Artuso <i>et al.</i>	(CLEO Collab.)

CRAWFORD	92B	PL B294 139	G. Crawford <i>et al.</i>	(CLEO Collab.)
HEINTZ	92	PR D46 1928	U. Heintz <i>et al.</i>	(CUSB II Collab.)
HEINTZ	91	PRL 66 1563	U. Heintz <i>et al.</i>	(CUSB Collab.)
MORRISON	91	PRL 67 1696	R.J. Morrison <i>et al.</i>	(CLEO Collab.)
NARAIN	91	PRL 66 3113	M. Narain <i>et al.</i>	(CUSB Collab.)
